cc - Dr. L. Henderson, Assistant Division Leader
Stored Products, Insects
Bureau of Entomology and Plant Quarantine
U. S. Department of Agriculture
Washington, D. C.

cc - Mr. J. B. Trotter
Mr. Donald Dunwody - New York
Mr. S. F. Teague, - Birmingham
Mr. H. A. Lovejoy - Charlotte
Mr. J. P. Ekberg - Washington, D.C.

March 17, 1953

Mr. Hamilton Laudani
P. O. Box 78
Savannah, Georgia

Dear Mr. Laudani:

Somewhat over a month ago I had the pleasure of speaking with Dr. Henderson in Washington and learned about your interest in working with Aroclors in conjunction with Pyrethrum and Piprynyl Butoxide insecticidal formulation for the protection of bags used to package grains, etc. Delay in writing you is due to my having been away from the office traveling for the past month and we regret that we were not able to contact you sooner.

Enclosed is a data sheet entitled, "Lindane-Aroclor Combinations," which describes some of the work done to date with Aroclors by various people at Beltsville, Maryland, at the Beltsville Station. Perhaps you are already well acquainted with the family of Aroclors, but as this may not be the case, I am glad to explain them as follows with reference to the enclosed bulletin numbered P-115 entitled, "The Aroclors." Please, refer to pages 4 and 5 of this bulletin where the members of the Aroclor family are listed and their physical characteristics are given. You will note that the Aroclors begin with the lower chlorinated materials which flow like water and then with increased chlorination we arrive at viscous liquids, then "liquid resins," and finally the resinous or solid Aroclors. The 1200 series of Aroclors is based on biphenyl chlorinated to the per cent by weight indicated by the last two digits of the serial number. That is to say, Aroclor 1254 is 54% by weight chlorinated biphenyl and this amount of chlorine corresponds to five chlorine atoms in the ring.

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Aroclor 1219 is mono chloro biphenyl; 1232, dichloro biphenyl; 1242, trichloro biphenyl; 1248, tetrachloro biphenyl; 1254, pentachloro biphenyl; 1260, hexachloro biphenyl; 1262, hepta-chloro biphenyl; 1268, nonachloro biphenyl.

The 5400 series Aroclors is based on terphenyl, or three benzene rings chlorinated to the per cent by weight indicated by the last two digits of the serial number.

There are also some mixtures in the family. For example, Aroclors 4465 and 2565 are both 65% chlorination by weight of a mixture of biphenyl and terphenyl base. Aroclor 4465 is based on 60% of biphenyl and 40% of terphenyl base while Aroclor 2565 is based on 75% of biphenyl and 25% of terphenyl mixture. The reason Aroclor 2565 is shown to be black in color is that it is a crude, undistilled member of the family (We would not suggest your using any of the undistilled Aroclors in your work. While these crude materials are about 1-1/2¢ a pound cheaper, they may contain small amounts of residual HCl which might be very deleterious in action against any cellulosic fibrous material).

The physical constants of interest to you, such as vapor pressure, nonflammability, solubility, etc., are described throughout Bulletin P-115.

On Page 19 of Bulletin P-115 is a chapter on dermatology and toxicology. If the Aroclors are heated sufficiently to develop vapors, it should be kept in mind that these vapors bear a degree of toxicity and should not be breathed continuously in excessive amounts as described in the chapter under dermatology and toxicology.

Referring again to the work done on the Aroclor-Lindane mixture, where the purpose of the Aroclor was to enhance the insecticidal life of the active toxicant, solubility of the toxicant in the Aroclor is recognized as a prime requisite. The attached table will give you a good indication of the relatively strong solvent power of Aroclor for DDT.

We do not have on hand similar data showing the solubility of lindane or Pyrethrum in Aroclor but hope to obtain this data. In the case of the mixture of lindane with equal portions of Aroclor 5460, the people at Beltsville found that the residue was a clear, transparent, homogeneous film indicating complete compatibility or mutual solubility of the compounds. The stability of this film was indicated when it withstood several months weathering after application to the leaves of a willow tree and continued to show strong insecticidal value against flies even after prolonged weathering.

Attachment No. 2 indicates, in a rough way, the expected compatibility of Aroclor with various non-halogenated insecticides. Here you will note our indicating compatibility of Aroclor and Pyrethrum.

Attachment No. 2 also indicates compatibility with Nicotine and in this connection we would like to refer to Report E-836, entitled, "Nicotine Insecticides, Part 7--Search for Synergists," issued by the U.S.D.A., Bureau of Entomology and Plant Quarantine, which indicates that lower chlorinated Aroclors such as Aroclor 1232 were one of the few of very many compounds screened which show synergism on Nicotine.

There is also published data indicating value of Aroclors as lousicides, miticides, larvacides, etc., and in this connection you are probably familiar with the report from the Orlando, Florida, laboratory covering screening tests run over the period of April, 1942 to 1947. This report is entitled, "Results of Screening Tests with Materials Evaluated as Insecticides, Miticides, and Repellents." The report number is E-733, and was issued in 1947 by the Bureau of Entomology and Plant Quarantine.

In our work here at Monsanto on wood preservatives and soil poisons, we have long recognized the strong termite repellent value of the lower chlorinated Aroclors running up to--say, Aroclor 1248.

The foregoing are merely some indications of the biological activity of the Aroclors. As best we can judge, it is the lower chlorinated members of the family that show the strong biological activity. As chlorination approaches--say, 50% or higher, this activity seems to diminish markedly, due no doubt, to the extreme stability and water insolubility of the more highly chlorinated members of the family. This sort of thing has also been noted in rodenticide studies where the Aroclors are being investigated by the Station in Denver, Colorado, and the lower chlorinated members were found to have some rodent repellent value.

The question of phyto-toxicity in many of these applications arises and it appears that some conflicting statements have been made on the matter of phyto-toxicity. It has been stated that the Aroclors are phyto-toxic but some investigators report that the Aroclors are not at all phyto-toxic. No doubt, this discrepancy arises from having worked with different members of the Aroclor family of products. We gather that the lower chlorinated Aroclors show phyto-toxicity against tender plants but that the more highly chlorinated members of the Aroclor family are relatively non-phyto-toxic. This is indicated by the data in Attachment No. 3 and is verified by additional similar data. With reference to the work done at Beltsville where the more highly chlorinated Aroclor resin materials were used in combination with lindane, it is my opinion, that the enhanced life of the lindane was accomplished mainly by physical effects resulting

from mixtures with the Aroclor resin rather than by synergistic action as may have been the case if lower chlorinated Aroclors had been used.

While we are not familiar with the details of the various application you may have in mind, we would suspect that in your work you would be mainly interested in the more highly chlorinated Aroclors to be used as bonding agents and to give increased life of the active insecticidal compounds. Accordingly, we are taking the liberty of sending you one pound experimental samples of Aroclors 1254, 1262, 4465, and 5460. If you would like to nominate any other member of the series, we would be most pleased to send similar samples. Also, if you need larger experimental quantities, we would be glad to supply them.

Referring to formulations such as Pyrethrum in combination with Piprynyl Butoxide where mineral spirits or kerosene type solvent may be commonly used, the question of Aroclor solubility arises. Please, refer to Bulletin P-115, Page 11, where solubility of Aroclors in hydrocarbons is indicated. Roughly, 50% solutions by weight in most aliphatic hydrocarbons can be easily made, although it may be required to warm the solvent to get rapid solution of the resinous Aroclors in it. The Aroclors are even more highly soluble in aromatic hydrocarbons such as Toluene, Xylene, and Benzene. We would not expect that you will encounter difficulty in making the desired solutions, but in case you run across a problem here, please, let us know the details and we will be glad to have our laboratory work on it or offer assistance to the best of our ability.

Also, the matter of emulsifying Aroclors may arise. There are an endless number of ways to emulsify Aroclors and as a very simple example we are enclosing data sheet numbered 4. The specific gravity of Aroclors is relatively high but notwithstanding this it is easy to emulsify the lower chlorinated liquid Aroclors. In case of the more highly chlorinated Aroclors, and particularly the resinous members, it is usually necessary to dissolve them in a hydrocarbon solvent before making the emulsion.

It is recalled that Dr. Henderson mentioned applying pyrethrum in clay coatings to cellulosic, fibrous materials by calendering operations. While I am not familiar with the details of this application, it would seem to me that in these cases where--say Pyrethrum and one of the resinous Aroclors are to be applied, it may be desirable to first make an intimate mixture of the Aroclor and the insecticide by heating them together until melted, cooling, and then grinding. Then the application could be made in the same manner that the pyrethrum itself would be applied normally. You may have some comments to make to us on the above suggestion to enlighten us.

Of course, it is important to know that the Aroclors are readily available and economical. In tankcars the price is $0.16 a pound, FOB our plants, and in ton lots delivered east of Denver, the price is $0.18-1/4 a pound. Less ton lots packaged in

standard containers, the price delivered is $0.18-3/4 a pound.

No doubt, when you have reviewed these brief and sketchy comments, you will have many additional questions which we will be glad to attempt to answer for you.

Another product of ours which may be of interest to you as a solvent or as an auxiliary solvent is our HB-40 which is described in the enclosed copy of Bulletin P-104. 100 grams of this solvent will easily dissolve about 50 grams of DDT at room temperature which places it into the category of being a relatively good solvent. It is relatively non-volatile, colorless, odorless, and relatively free from toxicity including phyto-toxicity. It sells for $0.17 a pound in tankcars.

A somewhat higher priced material, in the range of $0.40-$0.50 a pound, in single drums, but perhaps available at lower cost if it arrives at commercial production, is our phenylcyclohexane which is described in the enclosed copy of Bulletin P-110. Phenylcyclohexane is also a good solvent for DDT. 100 grams of it will dissolve at least 50 grams of DDT at room temperature. Phenylcyclohexane is colorless, relatively odorless, high boiling, and may be of interest to you.

Your indicated interest in our materials is greatly appreciated and we realize that there are probably many unanswered questions beyond the scope of this letter. I sincerely look forward to having the pleasure of meeting you in order that we can discuss these things more fully. I would like to call on you sometime at your convenience at Savannah and if you happen to be traveling in the St. Louis area, please, drop in and be our guest.

Very truly yours,

P. G. Benignus
Aroclor & Special Product Sales

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